

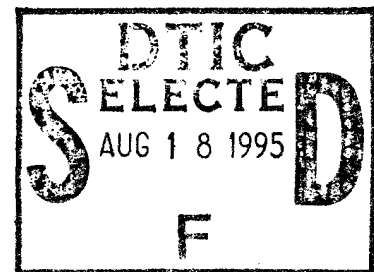
IDA PAPER P-3026

ANALYSIS OF DoD USAGE OF
MULTIMEDIA TECHNOLOGY TO
DETERMINE REQUIREMENTS FOR STANDARDS

Richard P. Morton, *Task Leader*

Christine Youngblut

March 1995



Prepared for

Center for Standards
Joint Interoperability and Engineering Organization
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PREFACE

This document was prepared by the Institute for Defense Analyses (IDA) under the Task Order, *Requirements for Standards for Storage, Transmission, and Display of Multimedia Information*, and relates to the objective of the task, "to assist the Center for Standards in developing approved multimedia standards." The work was sponsored by the Defense Information Systems Agency (DISA).

A peer review of this document, chaired by Dr. Richard J. Ivanetich, was performed by the following IDA research staff members: Dr. Alfred Brenner, Ms. Anne Douville, Dr. Michael Kappel, and Dr. Dale Lichtblau.

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EXECUTIVE SUMMARY

Multimedia Technology

Multimedia technology combines text, still images, video, audio and other forms of computer data to form a composite information object that can be manipulated and used to convey information in a useful, educational, entertaining, realistic, or more easily understood manner. Multimedia technology has been shown to improve effectiveness and reduce cost, particularly in training applications. Surveys of interactive videodisc instruction in military training settings found increases in the number of the students reaching mastery and lower costs.

Purpose and Scope

The intent of the study was to understand how the use of multimedia in DoD depends upon the portability and interoperability of hardware, software, and data products. There was no intent to determine the extent of multimedia technology penetration in DoD, nor to produce validated requirements. The first question that needed to be answered was whether there was, in fact, any need for standards in this area at present. The scope of the study included command and control (C2), intelligence, and all mission support areas. It also included weapon systems, sensors, medical and other laboratory equipment, simulators, and automated information systems.

Approach

A survey of selected DoD multimedia producers, consumers, and policy makers was undertaken to identify how multimedia technology is being used or anticipated for use and to identify the roles of portability and interoperability in those uses. In parallel with the survey, the activities of vendors and standards organizations were monitored to gain a better understanding of marketplace directions and trends in the development and use of standards.

Major Industry Findings

The multimedia industry is divided into the following communities for the purposes of this report:

- Education, Training and Public Relations
- Desktop Multimedia Publishing
- Information Retrieval
- Audiographic and Video Teleconferencing and Group Work
- Entertainment

Three general observations can be made about these communities. First, most of the products on the market are based on proprietary approaches and use proprietary data structures and file formats. Some proprietary products and file formats have reached the level of being *de facto* standards. Second, most available products are platform specific. That is, they operate only on an Apple Macintosh or with Microsoft Windows or with X Windows and Unix, but rarely more than one of these. Third, both proprietary technology and platform specific technology are changing through the use of translators and software ports, as well as through the adoption of open systems standards.

The importance to DoD of entertainment on the above list results from the fact that the potential size of the market for digital video and multimedia computer games is so large that some people expect this area to completely overwhelm all others in the standards definition process.

DoD Survey Findings

Current or planned uses of multimedia technology are described in terms of the following categories:

- Education, Training and Public Relations
 - Training, including classroom and distance learning situations
 - Advertising and public relations
- Desktop Multimedia Publishing
 - Briefings and presentations
 - Publications
 - Interactive Electronic Technical Manuals (IETM)
 - Mapping and charting
- Information Storage, Retrieval, and Dissemination
 - Information dissemination
 - Archiving photographs and video clips
- Teleconferencing and Group Work with and without Video
 - Video teleconferencing
 - Group work

Of the surveyed organizations exploring multimedia technology, almost half use a technical environment based on IBM-compatible personal computers. The other half is

essentially divided equally between Apple Macintosh and a variety of Unix environments. Several organizations indicated that they had or are developing a standard architecture for their multimedia systems.

When the DoD participants were asked to identify areas where standards are lacking, the most commonly mentioned need was cross-platform portability, that is, the ability to create multimedia materials on one type of computing platform (usually PC or Macintosh) for use on other types of computing platforms. The participants also identified the need for standards to support network uses of multimedia. Standards relating to video and audio were listed as needing improvement, particularly to provide better support for synchronizing video and audio in a single presentation. Several participants identified the need for standards in application areas of multimedia, such as training, presentations, and simulation, rather than standards for multimedia technology. In the area of training, several participants specifically described MIL-STD-1379D (Military Training Programs) as inadequate.

When asked what impact multimedia standards, or the lack of standards, had on their work, some of the participants indicated that the lack of standards is a problem for their organization; among this group of participants, a few were worried about the strong position *de facto* standards are achieving. Other participants indicated that they are happy with *de facto* standards, and do not see a need for anything else. For still others, the current level of open standards activity is about right. This last group of participants was the largest one, and expressed the opinion that the technology is still too immature for the standards to be more advanced than they are. They are in no hurry to see standards promulgated before the technology and the market are ready. For example, a strong contender for adoption as a *de facto* multimedia standard just a few years ago would have been Digital Video Interactive (DVI), but it is no longer of much importance in the industry.

The participants expressed the view that DoD should be actively involved in the standards definition process by participating, in a more coordinated way than at present, in the public standards bodies and industry consortia.

While there is some use of multimedia in production applications today, this use is very limited. Most of the participants indicated that their organizations are still in the development and piloting stages, but they expect the growth of multimedia usage will be dramatic.

Many participants expressed the hope that DISA would become a clearinghouse for multimedia information. They would like to see DISA publish information on standards and standards organization, as well as market directions and *Consumer Reports* kinds of analyses of commercially available products. A few participants expressed the need for procurement vehicles to assist in the acquisition of multimedia technology and hoped that DISA might provide such vehicles.

Conclusions

The following conclusions are presented in this report:

- There is a need for DoD standards in multimedia
- That need is not immediate
- *De facto* standards will play a significant role
- The need for guidance is immediate

In short, multimedia technology and standards are still too immature to recommend adopting any standards at this time. Moreover, it is not clear if the adoption of only open standards will ever be a sound policy in this area.

Recommendations

The following recommendations are made:

- The Center for Standards should provide multimedia technology standards guidance, but not promote standards policy, at this time.
- DISA should provide acquisition guidance on multimedia technology.
- DISA should maintain a repository of information on multimedia technology.
- DoD should be an active, coordinated participant in all multimedia standards forums.

Taken as a whole, these recommendation point to the need for DoD to develop (presumably within DISA) a detailed understanding of multimedia technology and standards because the subject is sufficiently complex that restrictive policies should be avoided, at least for the time being, and end users and program managers need somewhere to turn for advice.

1. INTRODUCTION

1.1 Background

Multimedia technology combines text, still images, video, audio and other forms of computer data to form a composite information object that can be manipulated and used to convey information in a useful, educational, entertaining, realistic, or more easily understood manner. In mission rehearsals, intelligence distribution, training, simulation, briefings, electronic commerce, public affairs, and many other functional activities, multimedia methods can help software and systems increase the effectiveness of DoD Service and civilian personnel. Multimedia technology underlies capabilities such as virtual reality and realistic rendering, both crucial to training and simulation. It is also an enabler for teleconferencing and other forms of group work that promises a new support paradigm for both warfighting and business functions of DoD.

Multimedia technology has been shown to improve effectiveness and reduce cost, particularly in training applications. A survey of 24 studies of interactive videodisc instruction in military training settings found "an increase of 25 percent in the number of the students reaching criterion mastery."¹ This study also reported "lower costs in every measured instance for interactive video disc instruction." A study on the effectiveness of multimedia technology in military medical training showed similar results, reporting that on one test the percentage of students passing went from 52 percent without multimedia technology to 98 percent with it.²

The Center for Standards (CFS) of the Defense Information Systems Agency (DISA) is charged with promoting standards for information technology in the DoD. In some cases, it develops DoD standards; in other cases, it recommends the adoption of standards developed outside DoD. To carry out this charge, CFS must understand the technol-

¹ J.D. Fletcher, *Effectiveness and Cost of Interactive Videodisc Instruction in Defense Training and Education*, IDA Paper P-2372, July 1990.

² *Interactive Multimedia Courseware Validation Report*, U.S. Naval Health Sciences Education and Training Command, Code 42, December 3, 1992.

ogy, the standards, and the general nature of the industry. This document supports these efforts in the area of multimedia technology.

1.2 Purpose and Scope

The purpose of this study was to determine DoD needs for standards for multimedia technology. For this study, the term 'multimedia' was loosely interpreted to include almost anything related to the use of audio, video, images, or animation in a computing or communications context. There was no intent to determine the extent of multimedia technology penetration in DoD. Nor was it the intent to produce validated requirements. The first question that needed to be answered was whether there was, in fact, any need for standards in this area at present.

The scope of the study addressed a wide range of DoD functional activities, including command and control (C2), intelligence, and all mission support areas. It also included weapon systems, sensors, medical and other laboratory equipment, simulators, and automated information systems (AIS).

1.3 Approach

The two most common drivers for information technology standards are portability and interoperability. Thus, the intent of the study was to understand in what ways the use of multimedia in DoD depended upon the portability of hardware, software, and data products, or the interoperability of hardware and software systems. A survey of selected DoD multimedia producers, consumers, and policy makers was undertaken to identify what uses of multimedia technology were underway or anticipated and to identify the roles of portability and interoperability in those uses. In parallel with the survey, the activities of vendors and standards organizations were monitored to gain a better understanding of marketplace directions and trends in the development and use of standards. Findings related to vendors of commercial off-the-shelf multimedia technology are described in Section 2 to serve as introductory discussion to the DoD survey findings in Section 3. An in-depth survey of multimedia standards was not undertaken for this report because sufficient work had been previously published by DISA.³ Conclusions and recommendations were then drawn from these two sets of findings, and are presented in Sections 4 and 5, respectively.

³ *Multimedia Technology Standards Assessment*, DISA JIEO CFS Information Processing Directorate, 15 September 1993.

2. VENDOR AND STANDARDS FINDINGS

2.1 Introduction

2.1.1 Information Sources

Information about vendor and standards activities was obtained from several sources that can be largely grouped into the following categories:

- Conferences and trade shows
- Publications
- Internet sources

Conferences and trade shows attended included the *Multimedia Expo*, sponsored by the Multimedia Development Group, New York, April 19-21, 1994; the *International Conference on Multimedia Computing and Systems*, sponsored by the IEEE Computer Society, Boston, May 15-19, 1994; and the *Desktop Video Conferencing Seminar and Exhibition*, sponsored by Indian Forest Research, Framingham, MA, August 24-26, 1994.

Periodicals found to contain useful information included *New Media* and *IEEE Multimedia*. Technical and marketing documents of numerous vendors were read at varying levels of scrutiny. Many standards and related documents were also studied. Additional standards-related periodicals that contain information relevant to multimedia were reviewed in conjunction with another DISA CFS task. Multimedia and standards are topics that are also discussed from time to time in many general-purpose computer and communications industry periodicals.

Internet sources included news groups, principally *comp.multimedia*, and file servers. For example, the International Telecommunications Union (ITU) maintains a document server for all of its standards, including those that were originally developed by the International Telephone and Telegraph Consultative Committee (CCITT), that provides status information and full text copies of standards.

2.1.2 General Observations

The multimedia industry is divided into several communities in a way that significantly impacts both the available technology and standards development. While there is overlap in the technical issues faced by each of the communities, there are different incentives that have led to different technologies and standards. These discussions in the subsections below are organized by the following communities:⁴

- Education, Training and Public Relations
- Desktop Multimedia Publishing
- Information Storage, Retrieval, and Dissemination
- Audiographic and Video Teleconferencing and Group Work
- Entertainment

To many people, the term 'multimedia' means the marriage of computers and video to produce products, called 'titles', for the interactive video and computer games industries. The incentive in these two communities today is mass marketing of CD-ROMs and other products, with the expectation that direct delivery into the home will follow by the end of the decade. The potential size of that mass market is so large that some people expect this area to completely overwhelm all others, for example, by dominating the discussions in standards bodies. It is for this reason that the entertainment community is included in this analysis, not because it will be functionally important to DoD.

Three general observations can be made about these communities. First, most of the products that are on the market are based on proprietary approaches, some of which have reached the level of being *de facto* standards. Second, most available products are platform specific. The dominant platforms are Apple and Intel/Microsoft; less common are the Unix platforms and Amiga. Even proprietary technology that is seen as 'the standard' in one platform community may be completely foreign in another. One exception to this is multimedia database management systems (DBMS). These are largely extensions to relational or object-oriented DBMSs and tend to be available for as wide a range of platforms as the original DBMS.

⁴ Anyone attending a broadly-based multimedia conference or trade show is likely to come away with his or her own dissection of the industry. The one outlined in this section is intended to reflect differences in technology and standards, and is not intended to be definitive, nor does it reflect any generally accepted consensus. It clearly differs from the list of applications given below in Section 3.3, which is intended to reflect DoD usage. There is only a partial correlation between the two lists.

Third, both of these, proprietary technology and platform specific technology, are changing through the use of translators and technology ports, as well as through the adoption of open systems standards. For example, there are many file formats in use for both still images and video, and many of these started out to be specific to a particular platform environment. When it comes to the development of multimedia products, the range of options is generally still limited based on the platform used, but there are programs for viewing the most common formats now available for Apple, Intel/Microsoft, and Unix platforms. Many vendors that started out offering products for any non-Intel/Microsoft platform have announced intentions to port their products to that environment. This is particularly true for Apple-based products. Historically, Apple systems were among the first ones used to produce multimedia products, and many of the most popular multimedia development tools came from the Apple community. Two of the biggest vendors in the Apple community are Adobe and Macromedia, both of which have released products for the Windows platform.

2.2 Education, Training, and Public Relations

One area of commercial focus on multimedia within education and training is in the area of discovery learning, simulations of real world phenomena that can be manipulated by the student. The intent is to make the simulation as much fun as possible to get students and parents (in the case of K-12 education) to buy the products themselves. Some of the existing products were originally developed for distribution on floppy disks, but have been upgraded to use more multimedia techniques and are now distributed on CD-ROMs. The dominant standard for CD-ROM is *Information Processing—Volume and File Structure of CD-ROM for information Interchange*, ISO 9660, but the encoding of data, including audio and video, on a CD-ROM is proprietary and somewhat platform specific.

There is also commercial interest in providing multimedia authoring systems for curriculum developers at all levels of education and training. Here, the intent is to add multimedia functionality to computer-assisted instruction and computer-based training for a variety of purposes, including making the material more interesting and providing more realistic examples of how to perform the skills being taught. For example, in teaching a procedure, the text description can be augmented with video clips showing someone carrying out each step. Multimedia authoring systems use proprietary technologies and file formats almost exclusively, the exception being that they use the common video compression and file formats for video clips. In particular, there are no standards for the file formats used to store lessons, for describing how to interpret student answers, for the data to be stored in a

teachers management information database, or for the look and feel of instructional materials so students do not have to learn a new interface with each new system encountered.

The technology and standards needed for public relations are similar to those used in education. The most common configuration for the use of multimedia technology in public relations is the information kiosk. The content is usually menu driven, and the user is provided with a touch-sensitive screen to point at the desired selections. Some systems use voice input as long as the vocabulary can be kept very small. Generally, the content is stored on a CD-ROM, although there may also be a data link to a central source, depending on the kind of information being dispensed. Some public relations systems have the capability to serve as a video conferencing system to connect the user to a human operator if the digital content is inadequate to satisfy user requirements. Public relations kiosks may also be equipped with a variety of additional devices for reading magnetic cards, issuing magnetic cards, printing tickets, or otherwise dispensing any number of other products or printed information.

2.3 Desktop Multimedia Publishing

The desktop multimedia publishing community is different from the CD-ROM oriented “edutainment”⁵ publishing community in the same way that desktop publishing and word processing differ from book publishing. Desktop multimedia publishing refers to the generation of multimedia “documents” intended for electronic distribution, generally on a no-fee basis, and generally to a limited audience. Some desktop publishing and word processing software provides the capability for generating hypertext, documents that contain highlighted words or phrases that the reader can select to branch to other parts of the document or even other documents. Some desktop publishing systems allow such links to go to images, sound clips, or video clips. At present, the file formats used in these systems are proprietary. In addition, the Mosaic program, a popular user interface and browser for resources available on the Internet, provides the capability to build indexes that contain pointers to other resources available on the Internet, including image, movie, and audio files. The format it uses, the hypertext markup language (HTML), is not proprietary, is an extension of the international standard SGML⁶, and has become a *de facto* standard for the Internet. In one sense, however, Mosaic is not strictly a multimedia program. When it

⁵ This term has been coined to designate the combination of the education and entertainment communities, particularly in CD-ROM and other software publishing fields. These are the areas currently targeted toward home computer users by mass marketers.

⁶ ISO 8879, *Standard Generalized Markup Language (SGML)*

encounters image, movie, and audio files, it executes other programs to display or play these files.

An ISO standard is under development to address the issue of interchanging multimedia products (documents in a very general sense). This standard is officially DIS 13522-1, *Coding of Multimedia and Hypermedia Information, Part 1: MHEG Objects Representation - Base Notation (ASN.1)*, and popularly referred to as MHEG. A companion standard is under development for a scripting language called Standardized Multimedia Scripting Language (SMSL), as well as two additional parts of 13522 for describing the relationship between MHEG and SMSL. It is too early to predict the success of these standards, except to point out that together they relate to multimedia in much the same way that SGML relates to text documents, and SGML has had very little success in solving text document interchange interoperability problems.

Just as there are specialized products for producing briefing slides in the text and graphics publishing community, there are specialized products for producing multimedia presentations that use technology and standards comparable to other multimedia publishing products.

2.4 Information Storage, Retrieval, and Dissemination

The problems of multimedia information storage and retrieval can be divided into the management of multimedia objects, such as in a database, and the retrieval of those objects based on the actual content of the object. As noted earlier, a number of DBMS and object management system (OMS) vendors explicitly support multimedia data and objects. Within the relational community, standards activity centers around the development of multimedia extensions to SQL, called MM-SQL. The object oriented (OO) community is still grappling with general OMS standards, waiting to see what is produced by the Object Management Group (OMG), a consortium. The result of OMG's work is expected to support multimedia objects. However, the MM-SQL standard has a better chance of becoming a commercial success because it is seen as the next generation of SQL, which has a very strong following in commercial practice. Several DBMS vendors already claim to be conformant with existing draft MM-SQL specifications.

A few commercial products perform context-sensitive searches on image databases. Typically, given a database of still pictures, one constructs a template of shapes and colors used to find images that look something like the template. The user can adjust the sensitivity of the template to include more or fewer responses. The intended customer for these

products is anyone, such as a graphic artist, who has a large library of stock photographs and needs to find, say, all pictures of airplanes or red flowers. There is no current standards activity in this area.

Standards for object dissemination are largely data type (audio, image, video, etc.) specific and distribution media (CD-ROM, diskette, network, etc.) specific. For distribution over networks, a *de facto* standard has developed based on a program called *uuencode*, originally developed for transmitting software between Unix systems. It encodes an arbitrary bit stream into ASCII characters for transmission over character-based networks such as electronic mail. *uuencode*, and the corresponding *uudecode*, are now freely available for most platforms.

2.5 Audiographic and Video Teleconferencing and Group Work

Technology to support people working together takes several forms that span a range of capabilities, some of which make use of multimedia technology. Vendors, trying to distinguish their products from others, classify this technology as one of several kinds of teleconferencing or group work. The distinction is somewhat arbitrary, but teleconferencing usually implies that the primary nature of the interaction is verbal and visual, with some use of documents to augment the discussion, whereas, group work usually implies that the primary nature of the task is simultaneous work on a document, possibly making use of verbal or visual contact between the co-workers. It is expected that teleconferencing will increasingly originate and terminate at desktops, rather than in specially equipped conference rooms. This will blur the distinction between teleconferencing and group work to the point where there will be interactive group work which may include audio and, if it does, then may also include video. Documents, spreadsheets, or other computer-resident supporting materials will be incorporated as needed into the discussion, either as the main topic or as supporting materials.

Most of the existing video teleconferencing systems designed to be special conference rooms or roll-around conferencing systems use proprietary telecommunications protocols and compression formats. Systems designed to be desktop systems, meaning incorporated into personal computers and workstations, tend to use open communications protocols because they need to use whatever communications are already in place to support the computers, but the compression algorithms are sometimes proprietary and sometimes based on open standards. The open standard most commonly used for video compression in teleconferencing systems is ITU-T Recommendation H.261. Vendors com-

mitted to open standards are adopting a new standard, Recommendation H.320, which provides a framework that incorporates the capability to coordinate document presentation and other aspects of a more complete system. H.261 is the video compression standard included in this framework. A range of additional standards from the ITU H, I, G, and AV series of Recommendations is also included in H.320 to specify other aspects of a teleconferencing system. In each case, there are criteria for selecting the appropriate standard from the range of alternatives. Available bandwidth is one of those criteria, for example for selecting the audio standard.

The ITU also has a set of Recommendations it refers to under the heading of audiographic teleconferencing. Audiographic teleconferencing is desktop teleconferencing with audio but not video. This mode of group work may become the dominant form because by eliminating video there are many cost savings in the computers and in the network. Vendors of this technology believe that users will find that for most cases the ability to see each other will not be important. The ITU Recommendation that lays out the framework for this area is F.710.

The desktop conferencing industry is trying to convince the world that it is about to "take off," but it is having difficulty getting its story coordinated. The claim is that desktop conferencing, primarily desktop video conferencing, will have the same explosive growth, just as soon as the standards are in place to provide interoperability, that facsimile transmission had when standards were introduced in that industry. At the moment, however, there are several major divisions in the underlying technologies and several gaps in the standards picture.

- One significant split in technological underpinnings is the communications channel by which the local nodes communicate in a conference. There are currently three major groups of vendors, those using public switched telephone network (PSTN, sometimes also called POTS—plain old telephone system), those using integrated services digital network (ISDN), and those using current computer networks, largely LANs, with asynchronous transfer mode (ATM) waiting in the wings. Since these underlying communications technologies do not readily interoperate today, this has a major impact on conferencing connectivity. The choice of communications technology also impacts the choice of compression technology, further hampering interoperability.
- Compression technology is another major problem for the industry. A year ago, H.261 was expected to become the industry compression standard for telecon-

ferencing, but for most platforms in use today, H.261 requires a hardware assist. Intel introduced Indeo as a cheaper alternative since it can be implemented in software, and many vendors have lined up to support Indeo. (But even Indeo is being sold only to operate over ISDN.) Some of the slower speed PSTN approaches are using ISO 10918, *Digital Compression and Coding of Continuous-Tone Still Images*, commonly known as JPEG (named for the group that developed it, the Joint Photographic Experts Group), a still image standard, further eroding support for H.261.

- Standards for audio coding and compression are just as confused as the video standards. The generally accepted standard for audio coding is 44khz. There is an ITU standard for compressing that to 16kbps called G.728. This standard is sufficiently complex that no one is even considering implementing it in software. Of course, slower speed systems, ones that only have 14.4 or 9.6 kbps, cannot use this audio compression standard. Even systems designed to operate over a single 56kbps or 64kbps channel generally do not use this standard. There is a new ITU standard for 7Kbps in a 64Kbps channel called G.722, but it has not been implemented in many products yet. Most vendors point out that while the video is the flashy part of the system, the audio is the more important part, and when bandwidth or compute power are limited, they will sacrifice video quality in order to sustain audio quality.
- In order for desktop conferencing to become a market success, it must provide more than just "talking head" communications. Sharing data and applications is generally considered to be the primary aspect that will have enough impact on productivity to create the desired market. Standards for data sharing do not yet exist, but they are being developed within the ITU structure under the general heading of T.120. The basic framework standard is scheduled to be ratified in the next few months, but the rest of the structure is still at least two years away.
- There are two approaches to permitting users to work within the same application space. *Application sharing* means each user is running a separate copy of an application. *Window sharing* means the application is only running on one computer, but all the participants in the conference have interactive copies of the window that the application is running in. There are no standards existing or under development for application sharing. There are several products available that provide application sharing, but they are all incompatible with each other.

Application sharing is, however, the capability that many people believe will be the one that eventually sells the business world on the value of teleconferencing. There is one standard available that addresses shared windows, namely SharedX, that works for situations where all participants in a conference have X-Windows environments.

- Cabling together a complete desktop video conferencing system today requires attaching numerous devices, both inside and outside the desktop workstation. While many new computers are coming to the market with some of these devices built in, there are numerous standards that govern the ways these devices are integrated. For example, there is a standard for how the communications interface board is to be connected to video CODECs (coder-decoder), and another one for how the CODEC is connected to the computer video board.
- The recently-formed Personal Conferencing Working Group (PCWG) is a consortium led by Intel and including Lotus, Novell, Microsoft, and others, set an agenda for itself to develop a series of Personal Conferencing Specifications (PCS), starting with version 1 released at the end of 1994 and version 2 due out about the same time as this report. The group claims that it will not be unfriendly toward standards, but it is clear that they are not waiting for any standards that are not yet developed. Their expressed mission is to make the personal computer the standard communications and video device of the future. They are after the mass market, and with the members they currently have, they could dictate much of the direction of the future development in the industry.

2.6 Entertainment

From the technical perspective of this study, interactive video and computer games are treated as different communities.

2.6.1 Digital Video

Traditionally, the production of high quality moving pictures, both for the movie screen and for broadcast television, demanded more picture quality than digital technology could deliver, except for special effects that required very expensive systems. With the advances in computing power of the last few years, this view is beginning to change. Some of today's video and audio editing software systems running on the latest personal computers rival studio grade equipment in a package that is easier to learn to use and at a small fraction of the price, but not with the same image resolution. This is making it possible for

organizations to do their own movie generation, for advertising, education, or other purposes.

The content in the digital video area consists of sound and video, including animation, but with limited use of computer-controlled interaction. The major issue for vendors in this community is how to get the home market to take off. The community, which has its roots in the movie and television industries, seems to be expecting that regardless of which utility carries the signals into the home, cable TV or telephone, the user will be viewing the content on a television set. As a result, the most pressing standards issue is the settop box that will provide the capability for user interaction. Several vendors have announced their intention to market a settop box, and some cable and telephone companies have announced plans for trials teamed with one of the settop box manufacturers.

Another standard of importance to this community is one for video and audio compression; at the moment, the community is backing the standards of the Moving Picture Experts Group (MPEG), ISO/IEC 11172, generally known as MPEG-I, and ISO/IEC DIS 13818, MPEG-II. In the production process, however, motion JPEG is the format of choice since it supports more flexibility in the editing process than does MPEG.

While the main focus of this community is on television services, interactive or not, delivered by wire of some sort to the home, there has been some experimentation with content on removable media. It seems to be recognized that there are enough CD-ROM drives in homes today to make a market, but the CD-ROM medium is seen to be too limited in capacity. The maximum duration for a video stream compressed with MPEG-I on CD-ROM is about 71 minutes, too short for the movie industry that thinks in terms of 90 minutes or more for a purely linear product. Video disks are larger and capable of storing complete movies, but are not common enough. A number of hardware manufacturers have announced products or research aimed at increasing the density of optical disk storage, although none are available at consumer prices, and no standards activities appear to be underway.

2.6.2 Computer Games

The content in the games area is predominantly animation, with computer-controlled interaction, sound, and some video. Most multimedia games are published on CD-ROM. Most independent publishers are using the ISO-9660 standard for CD-ROM formatting, but games are also available in proprietary formats, such as CDi (Philips) and 3DO. The standards used for audio and video are platform specific and proprietary. For example,

the most common video format for Apple computers is Quicktime, an Apple proprietary format, and the most common audio output standard for Intel/Microsoft platforms is SoundBlaster, a line of audio plug-in boards made by Creative Labs, Inc. The SoundBlaster audio standard so completely dominates the personal computer audio area that it will be very hard to dislodge with anything less proprietary.

With the growth of multi-player games on electronic bulletin boards and on the Internet, there is a lot of interest in exploring multimedia distributed games, and a few are available, generally the product of students in universities rather than commercial vendors.

3. DOD SURVEY DESCRIPTION AND FINDINGS

3.1 Structure of the Survey

The objective of the survey of DoD participants in multimedia activities was to answer a number of questions which can be summarized as follows:

- In what ways is multimedia technology being used or expected to be used in DoD?
- What multimedia technology is being used or expected to be used?
- What is the impact of the existence or lack of standards for multimedia technology on the use of that technology?

In addition, the subjective views of the participants were solicited with respect to their knowledge of on-going standards activities, how DoD should be participating in these activities, and, in general, what kinds of support in this area they would like to get from DISA.

To assist in answering these questions, a survey guide was developed (see Appendix A). In most cases, a copy of this guide was faxed to the participants to permit them to prepare for the interview that followed. In all but one case, a person-to-person interview was conducted, usually by telephone. A few of the participants were interviewed face-to-face when this was convenient.

3.2 Characteristics of Participants

Since the purpose of the survey was to uncover requirements within DoD for standards for multimedia technology, and not, for example, to determine the extent of usage of multimedia throughout the Department, it was judged not necessary to conduct a blanket survey of all DoD components. Instead, participants were selected based on the likelihood that they could make a positive contribution to the survey. An initial list of participants was developed based on:

- Membership in the DoD Multimedia Working Group

- Recipients of an earlier survey on DoD requirements for Multimedia
- Specifically known individuals, including people named in published articles about DoD uses of multimedia

Many additional names were added to the list over the course of the survey as the result of recommendations from other participants. Ultimately, 99 names ended up on the contact list, resulting in 56 interviews of members of 26 organizations within DoD and five in the Coast Guard (CG) (see Figure 1), plus two consultants and two individuals from the

• OSD	• Army	• Air Force
- ASD(PA)	- ODISC4	- AFC4
- ASD(C3I)	- TRADOC	- AETC
• Joint Staff	- TASC	• Marine Corps
- J-8	• Navy	- Stds. & Arch.
• PACCOM	- CNO	- Train. & Ed.
- Imaging	- National Naval Medical Center	• Cent. Imagery Off.
• STRATCOM	- NRL	• Nat'l. Defense Univ.
- Combat Camera, Visual Information	- NSWC	• Coast Guard
• DIA	- NPRDC	- Intelligence
• DLA	- NRAD	- Public Affairs
• DMA	- NAWSC	- Acquisition
• NSA		- Recruiting
		- Personnel

Figure 1. Participating DoD and Coast Guard Organizations

standards development community.

The DoD and CG representatives fall into the following categories (the numbers do not add up to the total because some people fall into multiple categories):

- 21 Users of multimedia materials (plus three more who plan to become users)
- 27 Producers of multimedia materials (plus three more who plan to become producers)
- 26 Policy makers

3.3 Uses of Multimedia

Current or planned uses of multimedia technology were described in terms of the following categories, grouped here to reflect their approximate relationship to the communities of interest listed in Section 2:

- Education, Training and Public Relations
 - Training, including classroom and distance learning situations
 - Advertising and public relations
- Desktop Multimedia Publishing
 - Briefings and presentations
 - Publications
 - Interactive Electronic Technical Manuals (IETM)
 - Mapping and charting
- Information Storage, Retrieval, and Dissemination
 - Information dissemination
 - Archiving photographs and video clips
- Audiographic and Video Teleconferencing and Group Work
 - Video teleconferencing
 - Group work

Multimedia training applications, as well as briefings and presentations, can be found in many DoD organizations. Some of the people involved in training applications indicated that they expected their organization to become dependent upon multimedia technology within the next few years. Much of the training DoD does today (outside of exercises) is conducted within classrooms, and most of the applications of multimedia are focused on that environment, but efforts are underway to reduce the dependency on bringing students to classrooms through a variety of techniques collectively known as distance learning. This includes transmitting instructional materials to students remotely using electronic means, as well as packaging up the materials in physical media such as diskettes or CD-ROMs and sending them to the student via the mail.

Advertising and public relations organizations are using multimedia technology in the development of both video tape applications and information kiosks, free standing, unattended places where people can access information, generally from a computer monitor. The Services are using these for recruiting, in some cases finding them to be more effective than the standard recruiting office because they can be placed in locations more convenient to potential recruits.

Presentations, basically briefings, can include multimedia information whenever it is appropriate to supplement basic text and graphics with additional media, such as photographs or video clips.

The use of multimedia in paper document publications is limited to the inclusion of photographs and other still images. Some DoD organizations are experimenting with electronic publishing (e.g., bulletin boards or Internet servers). Electronic documents can contain video and audio, as well as images, but they require the reader to have the necessary hardware and software to play them. This gap is rapidly closing since more than half of all personal computers being shipped today are multimedia equipped.

DoD expects the Interactive Electronic Technical Manual (IETM) to eventually lead to improvements in the productivity of maintenance personnel, but at the time of this survey only one IETM was found to be in use. An IETM is essentially an electronic manual with hypertext and hypermedia links to permit a technician to rapidly find the information needed for an installation or repair operation. The IETM can include video and audio to show and explain in ways no printed manual can how to carry out the operation. DoD, itself, does not expect to produce many IETMs since most will be produced by the contractors that manufacture the equipment to which the IETMs apply, but DoD personnel will be the users of the IETMs.

With the introduction of digital technology to mapping and charting, software has been developed to generate maps directly from aerial and satellite photographs. This leads to the possibility of overlaying the original photograph on the map to provide additional information to the map user.

The role of multimedia in information dissemination largely relates to images derived from intelligence sensors, digital photography, and digital video. Much of this is in support of efforts to improve sensor-to-shooter information dissemination. For example, the Combat Camera program falls into this category. There is also a growing use of the same kinds of digital image dissemination in the medical community.

DoD organizations that serve as repositories for photographs and video clips are converting to digital technology as much as possible to improve the retrieval and dissemination processes. Ultimately, authorized end users will be able to query, browse, and retrieve material remotely, freeing repository personnel to perform the labor intensive tasks of indexing and organizing the materials. A key technology for this application is storage, since the space required to store even a single photograph is large (one 8" by 8" photograph scanned at 1200 pixels per inch in 24-bit color requires 276 megabytes if not compressed, or about 1.4 megabytes with 200:1 compression).

Video teleconferencing through the use of special rooms and other facilities has been used widely in DoD for several years, but without any connection to computers. The introduction of desktop conferencing technology appears to have whetted the appetite of many in DoD, but thus far there are only a few pilot efforts underway. The lack of standards to permit the interoperation of competing desktop conferencing systems was cited by some survey participants as a major stumbling block.

Group work applications supporting the collaborative development of documents, spreadsheets, etc., have been available commercially for several years. The survey, however, uncovered only one DoD organization actively using group work applications, and a few others investigating them, generally in the context of desktop conferencing.

3.4 Products and Standards in Use

Of the surveyed organizations exploring multimedia technology, almost half use a technical environment based on the IBM-compatible personal computer. The other half is essentially divided equally between Apple Macintosh and a variety of Unix environments. There were three environments based on legacy systems that are being phased out. Eight organizations indicated that they had a standard architecture for their multimedia systems, and another eight indicated that they have standard architectures under development.

The survey participants also indicated that they are using or planning to use a wide variety of standards in their multimedia work, as shown in Figure 2.

3.5 Perceptions of Standards Needs

When the DoD participants were asked to identify areas where standards are lacking, the most commonly mentioned need was cross-platform portability, that is, the ability to create multimedia materials on one type of computing platform (usually PC or Macintosh) for use on other types of computing platforms. Today, most of the packages used by

• Communications	• Sound	• Image Capture
- TACO	- SMPTE	- RS 170
- Internet	- SND	• Video Teleconferencing
• Video	- AU	- MPEG
- Motion JPEG	• Images	- H.320
- MPEG	- JPEG	- H.261
- Quicktime	- GIF	- Indeo
• Interactive Video Disk	• File formats	• Platform Architecture
- MIL-STD-1379D	- SGML	- MPC II
• CD-ROM	- NITFS	• E-Mail
- ISO 9660	- IPTC	- MIME

Figure 2. Standards used by Participating Organizations

the participants to create multimedia products run only on one computing platform and only generate products that will run on the same platform.

A related problem mentioned by survey participants was the need for interoperability across a network. Here it was recognized that many standards are needed, including standards for network protocols, data interchange formats (for example, standards for animation and document formatting), and distributed computing.

Standards related to video and audio were listed as needing improvement. Participants described compression standards, particularly MPEG, as inadequate for the desired uses. Some of the participants expect MPEG-2 to meet their needs. In addition, the area of integration between video and audio was identified as needing standards.

Other areas the participants identified as needing standards were settop boxes (television interfaces which can decode compressed multimedia data) and application programming interfaces for digital signal processors (computer chips frequently found on interfaces to video and audio devices).

Several participants identified the need for standards in application areas of multimedia, rather than standards for multimedia technology. Training, presentations, and simulation were mentioned. In the area of training, several participants specifically described MIL-STD-1379D as inadequate. Video teleconferencing, sometimes considered a technology and sometimes an application, was also cited. From the perspective of video teleconferencing as an application, the participants pointed to the need for standards that tie together several technologies so that integrated systems obtained from one vendor will interoperate with the integrated systems of other vendors.

3.6 General Observations

The points made in the following paragraphs represent the analysts' understanding of comments made by the survey participants. In most cases it was not possible to get exact quotations. Except where noted, more than one person seemed to be expressing the same idea. It should be pointed out, however, that many of the participants know each other and attend the same meetings. Nevertheless, taken at face value, the comments were considered interesting enough for inclusion in this summary report.

The comments are grouped into the following areas:

- On the state of multimedia standards
- On DoD involvement in the standards process
- On the penetration of multimedia technology
- On what DISA should be doing

3.6.1 On the State of Multimedia Standards

Survey participants were asked what impact multimedia standards, or the lack of standards, had on their work. Some of the participants indicated that the lack of standards is a problem for their organization primarily because it inhibited the introduction of multimedia technology. Also, the lack of standards makes it difficult to share content across projects thereby lowering the effectiveness of multimedia activities. A few participants indicated that they were worried about the strong position *de facto* standards are achieving because it is becoming increasingly difficult to displace them with open standards whenever the open standards become available.

Other participants indicated that they are happy with *de facto* standards, and do not see any need for anything else. These participants indicated that the current commercial

market is supplying all the multimedia products they need. They can assemble a system from these products that has the capabilities required, so there is no requirement for open standards that might inhibit the vendors' ability to innovate.

For others, the current level of open standards activity is about right. Of the three viewpoints expressed, this one had the most support from the participants in this survey. In general, they expressed the opinion that the technology is still too immature for the standards to be more advanced than they are. These participants recognized that there are numerous standards under development, but are in no hurry to see them promulgated before the technology and the market are ready.

3.6.2 On DoD Involvement in the Standards Process

Most of the participants expressed the view that DoD should be actively involved in the standards definition process by participating in the public standards bodies and industry consortia. These participants also agreed that DoD should only write standards where there is a DoD-unique requirement, such as simulation. One of the participants observed that DoD is already involved in many standards activities, but this participation is not adequately coordinated. Two of the participants thought that the lack of enforcement of adopted standards was a problem.

3.6.3 On the Penetration of Multimedia Technology

While there is some use of multimedia in production applications today, this use is very limited. Most of the participants indicated that their organizations are still in the development and piloting stages. They do expect, however, that the growth of multimedia usage will be dramatic, even in the next two to three years. Some organizations expect to become dependent on multimedia technology within five years. Some of these organizations have developed and approved formal plans for the adoption of the technology.

The only contrary opinion was expressed by one person who expected the technology to remain too expensive for wide-spread penetration for 10 more years.

3.6.4 On What DISA Should be Doing

Many participants expressed the hope that DISA would become a clearinghouse for multimedia information. They would like to see DISA publish information on standards and standards organization, as well as market directions and *Consumer Reports* kinds of analyses of commercially available products.

A few participants expressed the need for procurement vehicles to assist in the acquisition of multimedia technology and hoped that DISA might provide such vehicles. They pointed out that acquisition vehicles would also help to promote desired standards by making the preferred way the easiest way.

4. CONCLUSIONS

Conclusion 1: There is a Need for DoD Standards in Multimedia

The basic requirements leading to the need for standards in DoD regarding the use of multimedia technology exist. That is, there are numerous examples of current and planned uses of multimedia in DoD where interoperability and portability are important requirements. While the needs for interoperability and portability are generally limited to partners within the DoD, there are also situations where one or more of the partners are outside DoD, for example, IETMs, where the originators may be contractors, and distributed applications, where networks may be provided by commercial carriers.

Conclusion 2: That Need is not Immediate

The urgency of DoD standards in multimedia is not high. There are several factors that suggest that the immediate adoption by DOD of standards for multimedia technology would be premature, such as the following:

- Multimedia technology lacks maturity.
- The standards for many multimedia technology areas are still under development.
- Even where standards are available, their success in the marketplace has not been demonstrated.
- Industry experience is too limited to identify which standards DoD should adopt.
- It is not completely clear which interfaces require standards. For example, while there are a very large number of image and video file formats, there are already translators from one format to another that run on all the most popular platforms. Why should DoD mandate the use of only one?

DoD use of multimedia technology is still in very early stages. Most users are still experimenting with the technology to see how it can best meet their needs. In many cases,

the range of choices is quite broad, and, while it would be useful to have guidance that would help narrow those choices, there is inadequate experience to mandate specific solutions at this time.

Conclusion 3: *De Facto* Standards will Play a Significant Role

The absence of open standards accepted by industry in many areas of multimedia technology is not an accident. Many vendors believe that while the market and the technology are still new they have the opportunity to establish their products as *de facto* standards. This applies to data formats, such as Indeo, the video compression format for teleconferencing marketed by Intel, and to application programming interfaces (API) such as the driver interface for SoundBlaster audio cards sold by Creative Labs. The example set by Microsoft in gaining market dominance, controlling the technology, and setting the standards has encouraged this attitude by any vendor who gets a major share of any market, regardless of how early in the technology maturity cycle it may be. This state of affairs will take several more years to sort itself out and needs to be monitored.

Conclusion 4: The Need for Guidance is Immediate

The multimedia industry is fragmented in the sense that to implement any single application, several products generally need to be integrated into a working system. At the same time, many of these products are new and contain many bugs, show a wide range of comparative advantages and disadvantages, and are incompatible with each other. DoD users, like users everywhere, need guidance on what is good, what is not good, what works with what, which products use which standards, which standards are open and which are proprietary, and other related facets of this confusing industry.

5. RECOMMENDATIONS

Recommendation 1: The Center for Standards should provide multimedia technology standards guidance, but not promote standards policy, at this time.

The approach to the formal adoption of multimedia technology standards by DoD should be based on a program that includes time for experimentation and exploration. Standards recommendations should be provided to those who want such guidance, but formal adoption should be delayed until sufficient experience with the technology and the standards makes clear which standards need to be adopted for what purpose. The standards guidance which is most applicable today needs to be application specific and has many unfilled holes, but in any new technology, following the period of rapid expansion with many players, there is usually a period of consolidation as ways are found to make the most widely used technologies do the work of some of the lesser used technologies. This is likely to happen with multimedia over the next several years.

Recommendation 2: DISA should provide acquisition guidance on multimedia technology.

Many organizations in DoD are planning to initiate experiments and pilot projects with multimedia technology. These organizations would like to avoid the mistakes of buying parts that do not meet their needs or parts that do not work well together. The kind of guidance they need, however, requires combining information that might reasonably come from several Divisions of the Joint Interoperability and Engineering Organization (JIEO), the Joint Interoperability Test Center, and possibly other DISA components.

Recommendation 3: DISA should maintain a repository of information on multimedia technology.

This recommendation builds on all the others. In addition to standards and acquisition guidance, many components of DISA can contribute to creating and maintaining a repository of technical and managerial advice on all the aspects of multimedia technology and the multimedia industry. A significant part of this recommendation has to do with main-

taining sufficient skills and understanding to be able to maintain such a repository. If this were accomplished, DISA would also be a center of technical expertise, able to provide assistance in the judicious and effective application of multimedia technology to DoD requirements.

Recommendation 4: DoD should be an active, coordinated participant in all multimedia standards forums.

There is already a lot of DoD involvement in all types of standards forums, including open committees and consortia. The only point of this recommendation is to encourage continued involvement and to encourage a more active role for DoD. DoD participation should be coordinated across all related activities. The DoD representatives should be knowledgeable enough to take proactive roles in their respective standards bodies, including chairing them whenever the opportunity permits. Since many standards, particularly the open ones, take several years to reach stability, DoD participation should be committed for the duration, if not by the same individuals, then at least with adequate planning to ensure continuity.

APPENDIX A. INTERVIEW FORM

[What follows is the interview guide as it was used during the DoD survey. In most cases it was faxed to the interviewees prior to conducting the actual interview.]

A series of interviews will be conducted to gather information concerning DoD requirements for multimedia standards. Determining these requirements will require an understanding of current, planned, and desired applications and technology for the production, distribution, and use of multimedia products and services. In addition, an understanding is required regarding existing, emerging, and planned multimedia standards and the extent of DoD involvement in multimedia standards organizations.

The purpose of this form is to provide guidance for conducting the telephone interviews. The more general sections, Parts I, II, and V, apply to all participants. Part III is for multimedia producers and Part IV for consumers; one or both of these sections may be appropriate.

Part I - General Section

- Ia. **Identification of participant.** Specifically, the name, organization/division, and position (with respect to multimedia involvement) of the participant.
- Ib. **Business of organization/division.** What is the primary business role of this organization/division? Does it, for example, develop training material, or prepare presentation and briefing materials.
- Ic. **Definition of *multimedia*.** How does the participant define this term?
- Id. **Impact of multimedia.** How has/does/will the availability of multimedia technology changed the organization's role/activities?
- Ie. **Multimedia producer, consumer, or both.** How does the participant classify his use of multimedia data?
- If. **Technical environment of the organization.** What technology and equipment does the organization employ to acquire and process multimedia information, and

to disseminate products or services to customers? What specific multimedia products are currently in use?

- Ig. **General overview of multimedia-related activities.** How widely is multimedia currently used, and expected to be used with in the organization? What changes are anticipated?
- Ih. **Introduction of multimedia into organization's operation.** What motivated/motivates the introduction of the use of multimedia? Were/are there specific cost-effectiveness or needed-capability analyses that provided the motivation? What type of planning/support was provided for this introduction? What lessons were learned?
- Ii. **General market views.** What is the participants opinion of the current multimedia market in general? What changes has he observed in this market in recent years? What are his expectations for the market? Are these opinions and expectations based on any formal analysis?

Part II - Standards Specific Information

- Iia. **Participants needs for multimedia standards.** What multimedia-related standards are being used? What additional standards are needed?
- Iib. **Work with multimedia standards organizations.** Which, if any, particular multimedia standards is the organization interested in? How is the development of these, and other, standards being monitored? What, if any, is the level of participation in standards organizations?
- Iic. **Perception of impact of standards, or lack of standards.** What impact does (the lack of) multimedia standards have on the organization's work? What future impact is anticipated? What particular issues are important, for example, portability, interoperability, or dissemination? Why are these important and what experiences have demonstrated this importance?

Part III - Producer Section

- IIIa. **Identification of product/services marketed.** What products or services does the organization provide to consumers?
- IIIb. **Identification of consumers.** Who are the organization's clients? How many people/locations are served? How are the products/services "sold" (for example, by fee-for-service)?

IIIc. **Organization's specific, current market expectations.** What are the participants perceptions of his clients' needs for multimedia products? How have these needs changed in recent years? How are these needs likely to change? Are these perceptions based on any formal analyses? What actions has the organization taken, or plans to take, to meet these needs?

IIId. **Market plans.** What actions has the organization taken, or plans to take, to meet market needs? Does the organization plan to support additional groups of clients? If so, what are these groups and why, and how, will they be supported?

IV - Consumer Section

IVa. **Identification of products/services consumed.** What products or services does the organization use? How are these acquired?

IVb. **Multimedia requirements.** What are the current needs for multimedia data? How have needs changed in recent years? How are they likely to change in the future?

IVc. **Producers' multimedia capabilities.** How well are (non)-DoD producers meeting the current needs? How well are they expected to meet future needs?

Part V - Closing Section

Va. **Additional points.** What special points would the participant like to make? What issues does he feel have been ignored?

Vb. **Other contacts.** Are there people the participant recommends as additional contacts (either internal or external to the organization)?

Vc. **Survey results.** Would the participant like to see of copy of the final survey results? (If so, make sure we have his fax number or mailing address.)

Vd. **Provision of examples.** What materials (in particular, videotape) would the participant like to share to promote their work.

LIST OF ACRONYMS

AETC	Air Education and Training Command
AFC4	Air Force Command, Control, Communication and Computers
AIS	Automated Information Systems
API	Application Programming Interface
ASD	Assistant Secretary of Defense
ATM	Asynchronous Transfer Mode
CCITT	International Telephone and Telegraph Consultative Committee
CFS	Center for Standards
CG	Coast Guard
CNO	Chief of Naval Operations
CODEC	Coder-decoder
DBMS	Database Management Systems
DIA	Defense Intelligence Agency
DISA	Defense Information Systems Agency
DLA	Defense Logistics Agency
DMA	Defense Mapping Agency
DOD	Department of Defense
DVI	Digital Video Interactive
GIF	Graphic Interchange Format
HTML	Hypertext Markup Language
ISDN	Integrated Services Digital Network
ISO	International Organization for Standards
IETM	Interactive Electronic Technical Manual
IPTC	International Press Telecommunications Council

ITU	International Telecommunications Union
JIEO	Joint Interoperability and Engineering Organization
JPEG	Joint Photographic Experts Group
MIME	Multimedia Internet Mail Extensions
MM-SQL	Multimedia Structured Query Language
MPC	Multimedia Personal Computer
MPEG	Moving Picture Experts Group
NAWSC	Naval Air Warfare Systems Center
NITFS	National Image Transfer Format Standard
NPRDC	Naval Personnel Research & Development Center
NRaD	Naval Command, Control and Ocean Surveillance Center Research, Development, Test and Evaluation Division
NRL	Naval Research Laboratory
NSA	National Security Agency
NSWC	Naval Surface Weapons Center
OMG	Object Management Group
OMS	Object Management System
OO	Object Oriented
OSD	Office of the Secretary of Defense
PCS	Personal Conferencing Specifications
PCWG	Personal Conferencing Working Group
POTS	Plain Old Telephone System
PSTN	Public Switched Telephone Network
SGML	Standard Generalized Markup Language
SMSL	Standardized Multimedia Scripting Language
SMTPE	Society of Motion Picture and Television Engineers
SQL	Structured Query Language
TACO	Tactical Communications

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